

## **WHAT IS CLAIMED IS:**

1. A process for forming a nanostructure comprising:  
providing a metal to a reaction chamber;  
heating the reaction chamber to a reaction temperature, the reaction  
5 temperature being greater than the melting point of the metal such that the metal becomes molten;  
flowing a first vapor stream comprising a first reactant through the reaction chamber; and  
reacting the molten metal with the first reactant at ambient pressure via a  
10 thermal chemical vapor deposition reaction process to form a first reaction product, wherein the first reaction product exhibits low solubility and low wetting characteristics with respect to the molten metal; and  
forming a nanowire or a nanobelt comprising the first reaction product.
2. The process of claim 1, wherein the metal is a low melting point metal.
- 15 3. The process of claim 1, wherein the metal is selected from the group consisting of gallium, indium, zinc, tin and cadmium.
4. The process of claim 2, wherein the reaction temperature is at least about 200°C above the melting point of the metal.
5. The process of claim 2, wherein the reaction temperature is at least about  
20 250°C above the melting point of the metal.
6. The process of claim 2, wherein the reaction temperature is between about 700°C and about 1500°C.
7. The process of claim 2, wherein the reaction temperature is between about 700°C and about 1200°C, and the nanostructure is a nanowire.
- 25 8. The process of claim 2, wherein the temperature is between about 1000°C and about 1500°C, and the nanostructure is a nanobelt.
9. The process of claim 1, wherein the first reactant is selected from the group consisting of oxygen, ammonia, hydrogen sulfide, phosphine, arsine, and fluorine.
10. The process of claim 1, wherein the nanostructure is formed on a  
30 substrate selected from the group consisting of silicon, quartz, glass carbon, graphite, pyrolytic boron nitride and alumina.

11. The process of claim 1, further comprising:  
ceasing the flow of the first vapor stream;  
flowing a second vapor stream through the reaction chamber subsequent  
to the flow of the first vapor stream, wherein the second vapor stream comprises a  
5 second reactant, different than the first reactant; and  
reacting the molten metal with the second reactant via a thermal chemical  
vapor deposition process at ambient pressure, wherein the reaction product of the  
molten metal and the second reactant exhibits low solubility and wetting characteristics  
with respect to the molten metal, the nanostructure further comprising the reaction  
10 product of the molten metal and the second reactant.
12. The process of claim 11, wherein the second reactant is selected from the  
group consisting of oxygen, ammonia, hydrogen sulfide, phosphine, arsine, and fluorine.
13. The process of claim 11, further comprising flowing an inert gas through  
the reaction chamber subsequent to the flow of the first vapor stream and prior to the  
15 flow of the second vapor stream.
14. The process of claim 1, wherein the reaction product is a semiconductor  
material, the vapor stream further comprising a dopant, the nanostructure comprising a  
doped semiconductor material.
15. A process for forming a hybrid nanostructure comprising:  
20 providing a metal to a reaction chamber;  
heating the reaction chamber to a reaction temperature, the reaction  
temperature being greater than the melting point of the metal such that the metal  
becomes molten;  
flowing a vapor stream comprising two or more reactants through the  
25 reaction chamber, wherein the two or more reactants have similar affinity for the molten  
metal;  
reacting the molten metal with the two or more reactants simultaneously at  
ambient pressure via a chemical vapor deposition reaction process, the reaction  
products of the molten metal with each of the two or more reactants exhibiting low  
30 solubility and low wetting characteristics with respect to the molten metal; and

forming a nanowire or a nanobelt comprising a hybrid of the two or more reaction products.

16. The process of claim 15, wherein the metal is selected from the group consisting of gallium, indium, zinc, tin and cadmium.

5 17. The process of claim 16, wherein the reaction temperature is at least about 200°C above the melting point of the metal.

18. The process of claim 15, wherein the vapor stream comprises two or more reactants selected from the group consisting of hydrogen sulfide, phosphine, arsine, and fluorine.

10 19. The process of claim 16, wherein the reaction temperature is between about 700°C and about 1500°C.

20. The process of claim 16, wherein the reaction temperature is between about 700°C and about 1200°C, and the nanostructure is a nanowire.

15 21. The process of claim 16, wherein the temperature is between about 1000°C and about 1500°C, and the nanostructure is a nanobelts.

22. A process for forming a hetero-nanostructure comprising:  
providing a metal to a reaction chamber;  
heating the reaction chamber to a reaction temperature, the reaction temperature being greater than the melting point of the metal such that the metal  
20 becomes molten;  
flowing a first vapor stream comprising a first reactant through the reaction chamber;  
reacting the molten metal with the first reactant at ambient pressure via a thermal chemical vapor deposition reaction process wherein the first reaction product  
25 thus obtained exhibits low solubility and low wetting characteristics with respect to the molten metal;  
forming a first length of a nanowire or a nanobelt comprising the first reaction product;  
flowing a second vapor stream through the reaction chamber subsequent  
30 to the flow of the first vapor stream, wherein the second vapor stream comprises a second reactant different from the first reactant;

reacting the second reactant with the metal at ambient pressure via a thermal chemical vapor deposition process, wherein the second reaction product thus obtained exhibits low solubility and low wetting characteristics with respect to the molten metal; and

5                    forming a second length of the nanostructure adjacent the first length, the second length comprising the second reaction product.

23.    The process of claim 22, wherein the metal is a low melting point metal.

24.    The process of claim 23, wherein the reaction temperature is at least about 200°C above the melting point of the metal.

10           25.    The process of claim 23, wherein the reaction temperature is between about 700°C and about 1500°C.

26.    The process of claim 23, wherein the reaction temperature is between about 700°C and about 1200°C, and the nanostructure is a nanowire.

27.    The process of claim 23, wherein the temperature is between about  
15    1000°C and about 1500°C, and the nanostructure is a nanobelt.

28.    The process of claim 22, wherein the first reactant and the second reactant are independently selected from the group consisting of oxygen, ammonia, hydrogen sulfide, phosphine, arsine, fluorine and mixtures thereof.

29.    The process of claim 22, further comprising flowing an inert gas through  
20    the reaction chamber subsequent to flowing the first vapor stream through the reaction chamber and prior to flowing the second vapor stream through the reaction chamber.

30.    A process for forming a doped nanostructure comprising:  
         providing a metal to a reaction chamber;  
         heating the reaction chamber to a reaction temperature, the reaction  
25    temperature being greater than the melting point of the metal such that the metal becomes molten;

         flowing a vapor stream comprising a reactant and a dopant through the reaction chamber; and

         reacting the molten metal with the reactant at ambient pressure via a  
30    thermal chemical vapor deposition reaction process to form a first reaction product,

wherein the first reaction product exhibits low solubility and low wetting characteristics with respect to the molten metal; and

forming a nanowire or a nanobelt comprising the first reaction product and the dopant.

5           31.    The process of claim 30, wherein the metal is selected from the group consisting of gallium, indium, zinc, tin and cadmium.

          32.    The process of claim 31, wherein the reaction temperature is at least about 200°C above the melting point of the metal.

          33.    The process of claim 31, wherein the reaction temperature is between  
10   about 700°C and about 1500°C.

          34.    The process of claim 31, wherein the reaction temperature is between about 700°C and about 1200°C, and the nanostructure is a nanowire.

          35.    The process of claim 31, wherein the temperature is between about 1000°C and about 1500°C, and the nanostructure is a nanobelt.

15          36.    The process of claim 30, wherein the reactant is oxygen and the dopant is selected from the group consisting of ammonia, hydrogen sulfide, phosphine, arsine, and fluorine.

          37.    The process of claim 30, wherein the reactant is ammonia and the dopant is selected from the group consisting of hydrogen sulfide, phosphine, arsine, and  
20   fluorine.

          38.    A hybrid nanostructure comprising the reaction product materials of two or more simultaneous thermal chemical vapor deposition reactions, each reaction including a molten metal reactant component and a vapor phase reactant component, wherein the two or more simultaneous reactions share the molten metal component  
25   and have different vapor phase reactant components, the different vapor phase reactant components having similar affinity for the molten metal.

          39.    The hybrid nanostructure of claim 38, wherein the different vapor phase reactant components are selected from the group consisting of hydrogen sulfide, phosphine, arsine, and fluorine.

30          40.    The hybrid nanostructure of claim 38, wherein the metal is selected from the group consisting of gallium, indium, zinc, tin and cadmium.

41. The hybrid nanostructure of claim 38, wherein the metal is gallium.

42. A hetero-nanostructure comprising two or more materials in discrete sections along the axial length of the hetero-nanostructure, wherein each discrete material is the thermal CVD reaction product of a metal and at least one vapor-phase reactant, the metal being consistent throughout the length of the hetero-nanostructure.

43. The hetero-nanostructure of claim 42, wherein the vapor-phase reactant is selected from the group consisting of oxygen, ammonia, hydrogen sulfide, phosphine, arsine, fluorine and mixtures thereof.

44. The hetero-nanostructure of claim 42, wherein the metal is selected from the group consisting of gallium, indium, zinc, tin and cadmium.

45. A nanostructure comprising a material selected from the group consisting of gallium sulfide, indium sulfide, and tin nitride, wherein the nanostructure is a nanobelt or a nanowire.